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Type studies on two species of *Phylloporus* (*Boletaceae, Boletales*) described from southwestern China

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Abstract —Type specimens of two *Phylloporus* species originally described from southwestern China were studied. The concept of *P. luxiensis* is refined with additional recently collected materials, while *P. scabrosus* is revealed to be a member of the genus *Lentinus*.

Key words — morphology, revision, taxonomy

Introduction

Phylloporus Quél. is a diverse genus in the *Boletaceae*, the hymenophore of which is predominantly lamellate instead of poroid (Neves & Halling 2010). Thirteen species and one variety have been reported from China (Teng 1963; Zang & Zeng 1978; Li et al. 1992; Bi et al. 1993, 1994, 1997; Dai & Li 1994; Zang et al. 1996). However, some remain poorly known, especially *P. luxiensis* and *P. scabrosus*, both originally described from the southwestern region of the country (Zang & Zeng 1978). Only scanty information on microstructures was provided when the two species were first described with excellent vividly colored plates of basidiomata (Zang & Zeng 1978); although both taxa were later cited (Zang et al. 1996, Li & Song 2003), no additional morphological information was given. Because many *Phylloporus* collections have recently been made in the region, it is necessary to re-examine the types of the two species to characterize them in more detail. The species are described below based on critical examination of the holotypes and additional collections.

Materials & methods

The *P. luxiensis* and *P. scabrosus* holotypes and other *P. luxiensis* collections are deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese

Academy of Sciences (HKAS). For comparison, the holotype of *P. sulcatus* (Pat.) E.-J. Gilbert deposited in the Farlow Herbarium, Harvard University (FH) was also examined. 5% KOH was used as a mounting medium for microscopic studies. The notations "basidiospores (n/m/p)" indicate that the measurements were made on *n* basidiospores from *m* basidiomata of *p* collections. Dimensions of basidiospores are given using the notation (a–)b–c(–d); where the range b–c represents a minimum of 90% of the measured values, and extreme values (a and d) are given in parentheses. Q refers to the length/breadth ratio of basidiospores; Q_m refers to the average Q of basidiospores ± sample standard deviation. All line drawings of microstructures were made from rehydrated material. For the convenience of the readers, the original Latin protologue of the two taxa are provided.

Taxonomy

Phylloporus luxiensis M. Zang, Acta Microbiol. Sin. 18: 283, Pl. II: 1–4, 1978.

Figs. 1–3

Latin protologue — "*Pileus centralis, 5–6.5 cm latus, convexus demum plano-convexus vel concavus, siccus, griseo-umbrinus, subtestaceus vel griseo-fuscus. Stipes 1–1.5 × 5–6.5 cm, cylindricus vel basim versus attenuatus, concolor, spongioso-cavus, myceliis flavido-albis. Lamellae distantes, irregulares, decurrentes, flavidae. Basidiosporae ellipsoideae, subfuscoideae, 4–5 × 8.9–12.5 μm, laeves, hyalino-flavidae, 1-pleures guttulatae. Basidia 4-sporigera. Pleurocystidia numerosa, 12–16 × 25–35 μm, fusiformia, cylindracea vel late ellipticae, asperata, verruculosa. Cheilocystidia similia. Odor* [as "Oder"] *gratus et sapor subnullus.*" (Zang & Zeng 1978).

Type study — The holotype of *P. luxiensis* consists of a basidioma and a spore print wrapped in a paper possessing the following characters: Pileus 3.3 cm in diameter, convex; surface dry, yellowish brown, tomentose, margin inrolled. Hymenophore lamellate, decurrent. Lamellae distant, yellow, about 0.3 cm in height. Lamellulae common, concolorous with lamellae. Stipe central, 4.5 × 0.5 cm, cylindric, base slightly enlarged 1.2 cm; surface dry, with very small, reddish brown to yellowish brown, grayish brown squamules; the upper ribbed by the decurrent lines of the lamellae. Basal mycelium yellow. Annulus absent. Spore print pale yellowish brown.

Basidiospores [40/1/1] 10–12 × (4–)4.5–5 μm, Q = 2.00–2.44(–2.56), $Q_m = 2.26 \pm 0.15$, yellowish to yellowish brown in KOH, subfusiform to ellipsoid, slightly thick-walled (up to 0.7 μm), smooth under the light microscope, but with bacillate ornamentation under SEM (Figs.1 c–d, 2c). Pleurocystidia 51–67 × 12–17 μm, ventricose or subclavate, thin- to slightly thick-walled (up to 1 μm), colorless to yellowish in KOH (Fig. 2e). Hymenophoral trama hyphae 4–15 μm in diameter, thin-walled, colorless to yellowish in KOH. Basidia, Cheilocystidia and Pileipellis not recovered. Clamp connections not seen.

Study of additional collections — Basidiomata medium-sized (Fig. 1a–b, 2a). Pileus (2–)4–8 cm in diameter, convex, then applanate, center

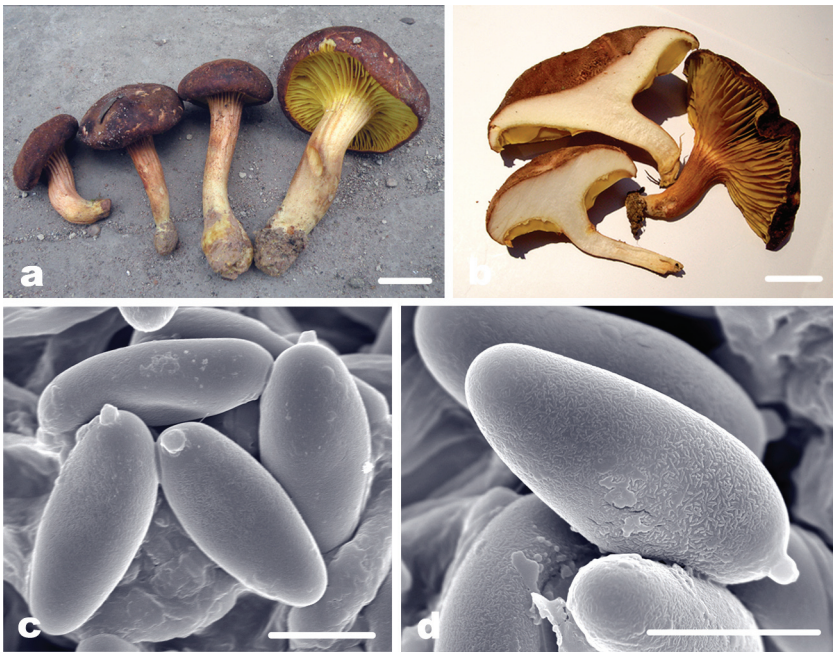

Fig. 1. *Phylloporus luxiensis* (a from HKAS 57048; b from HKAS 52242; c–d from HKAS 57036). a–b. Basidiomata. c–d. SEM from dried specimen detailing bacillate ornamentation of basidiospores. Bars: a–b = 2 cm; c–d = 5 μm.

slightly depressed when old, but not infundibuliform; surface dry, brown, densely tomentose, covered with brown, cinnamon-brown to grayish brown squamules, margin inrolled; context white, unchanging in color when injured. Hymenophore lamellate, decurrent. Lamellae moderately distant, up to 0.6 cm in height, occasionally anastomosing, yellow, dull yellow to ochre yellow, unchanging in color when injured. Lamellulae attenuate, concolorous with lamellae. Stipe central, 2–6 × 0.3–1 cm, cylindric, attenuate downwards, sometimes slightly enlarged at base (up to 1.4 cm), solid, firm; surface dry, upper half ribbed by the decurrent lines of the lamellae, with minute, reddish brown or purplish red squamules, lower half with yellowish brown, brown or grayish brown squamules; context white, unchanging in color when injured. Basal mycelium yellow. Annulus absent. Odor indistinct.

Basidiospores [300/15/4] (8–)9.5–12.5(–14) × (4–)4.5–5(–5.5) μm, Q = (1.60–)1.90–2.70(–3.11), Q_m = 2.21 ± 0.25, yellowish to yellowish brown in KOH, smooth, subfusiform to ellipsoid, slightly thick-walled (up to 0.7 μm) (Fig. 2c). Basidia 33–44 × 9–10 μm, clavate, think-walled, 4-spored, hyaline to yellowish in KOH; sterigmata 4–5 μm long (Fig. 2d). Hymenophoral trama composed of thin-walled hyphae 3–14 μm in width, colorless to yellowish in

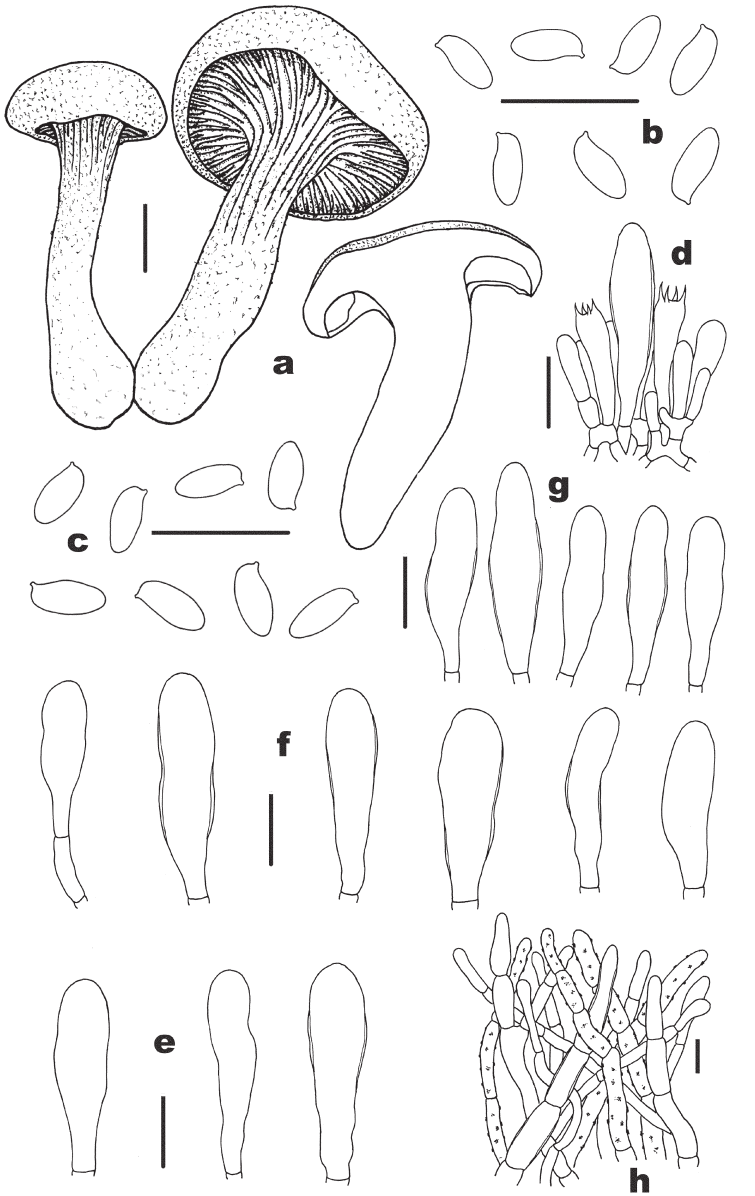

Fig. 2. Macroscopic and microscopic features of *Phylloporus luxiensis* (a from HKAS 57048; b, e from HKAS 40150, holotype; c–d, f–h from HKAS 57036). a. Basidiomata. b–c. Basidiospores. d. Basidia and pleurocystidium. e. Pleurocystidia. f. Cheilocystidia. g. Pleurocystidia. h. Pileipellis. Bars: a = 2 cm; b–h = 20 μm.

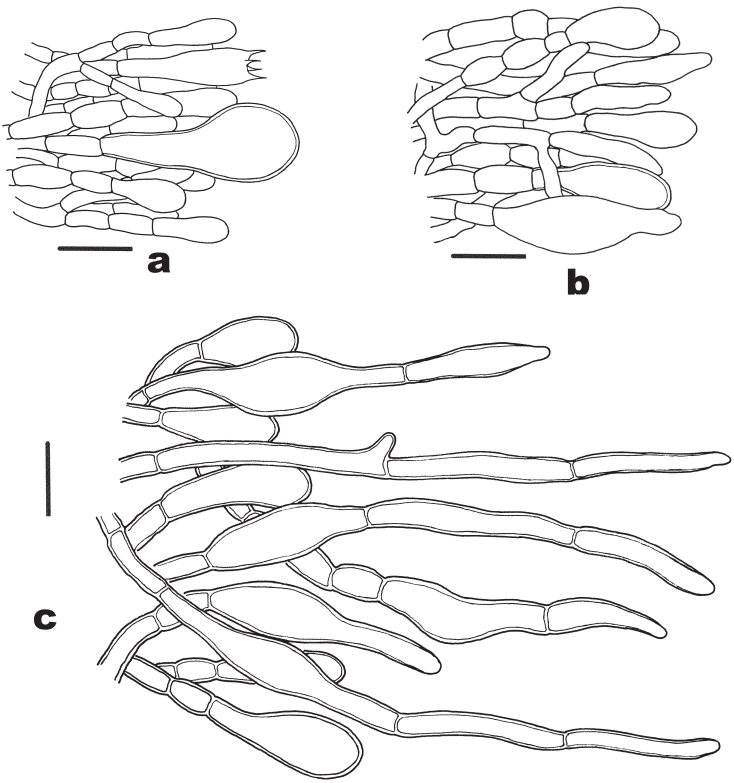

Fig. 3. Stipitipellis of *Phylloporus luxiensis* (HKAS 57036). a. From the apex of the stipe. b. From the middle part of the stipe. c. From the basal part of the stipe. Bars= 20 μm.

KOH. Cheilocystidia 36–65 × 10–19 μm, abundant, ventricose, subfusiform or subclavate, thin- to slightly thick-walled (up to 1 μm), colorless to yellowish in KOH, no encrustations (Fig. 2f). Pleurocystidia 42–105 × 10–19 μm, abundant, ventricose, subfusiform or subclavate, thin- to slightly thick-walled (up to 1 μm), colorless to yellowish in KOH, no encrustations (Fig. 2d,g). Pileipellis a slightly interwoven trichoderm composed of yellowish, 5–13 μm wide, thin- to slightly thick-walled (up to 1 μm), occasionally branching hyphae usually with yellowish granular encrustations, and clavate or subcylindrical terminal cells (20–62 × 5–12 μm) with attenuated or obtuse apex (Fig. 2h). Pileal trama composed of 4–12 μm wide, thin-walled, colorless to yellowish, interwoven hyphae. Stipitipellis a trichoderm-like structure; at the apex of the stipe composed of thin- to slightly thick-walled (up to 1 μm) hyphae with

narrowly or broadly clavate terminal cells (30–46 × 8–18 μm), and occasionally with clavate, 4-spored basidia (33–43 × 9–11 μm) (Fig. 3a); at the middle part of the stipe composed of thin- to slightly thick-walled (up to 1 μm) hyphae with clavate or subfusiform terminal cells (28–50 × 8–18 μm) (Fig. 3b); at the basal part of the stipe composed of slightly thick-walled (up to 1.5 μm) hyphae with broadly clavate or subfusiform terminal cells (30–71 × 14–20 μm), and many 3–20 μm wide, slightly thick-walled (up to 1.5 μm), emergent hyphae with clavate or subcylindrical terminal cells (33–50 × 5–9 μm) (Fig. 3c). Stipe trama composed of 4–10 μm wide, cylindrical, thin- to slightly thick-walled (up to 0.5 μm), colorless to yellowish in KOH, parallel hyphae. Clamp connections absent in all tissues.

Known distribution — Southwestern China.

Specimens examined — ***Phylloporus luxiensis***: **CHINA**. **Yunnan Province**: Mang City (previously called "Luxi County"), Chengguan Town, Xiadong, in the forest dominated by *Pinus* and *Quercus*, 3 July 1977, X.J. Li 90–HK2919 (HKAS 40150, **holotype**); Chuxiong Yi Autonomous Prefecture, bought from market, 26 August 2007, Z.L. Yang 4925 (HKAS 52242); Nanhua County, bought from market, 2 August 2009, L.P Tang 1079 (HKAS 57036); bought from market, 2 August 2009, L.P Tang 1080 (HKAS 57037); bought from market, 3 August 2009, L.P Tang 1091 (HKAS 57048).

Phylloporus sulcatus: **VIETNAM**. **Tonkin**: Vallée du Da-Pounian, 1907, Eberhardt LBA 210 (FH 3725, **holotype** of *Phylloporus sulcatus*), det. N.T. Patouillard.

Comments — In the protologue, the outer surface of the cell wall of cystidia was described as "verrucous". However, our observations differ from the original description.

Phylloporus luxiensis, originally described from Luxi County (now called "Mang City") in southwestern Yunnan, is well characterized by its brown, cinnamon-brown to grayish brown pileal surface, the reddish brown to yellowish brown, brown, or grayish brown stipe surface, the absence of staining of lamellae and context, and the non-inflated pileipellis hyphae.

Four collections cited above (HKAS 52242, 57036, 57037, 57048) matched well with the re-examined holotype and original illustrations. Our nuc-LSU and ITS sequence analyses (unpublished data) cluster all four collections together with a high statistic support. Unfortunately, no DNA sequences were successfully generated from the holotype.

Phylloporus sulcatus, a relatively unknown taxon described originally from Vietnam, shares some common characters with *P. luxiensis* (Patouillard 1909, Perreau & Joly 1964, Corner 1970). One of us (ZLY) studied the *P. sulcatus* holotype (FH–sheet 3725; Harvard University, Farlow Herbarium), which consists of the single collection, Eberhardt LBA 210. In the protologue of *P. sulcatus*, Patouillard (1909) cited a single locality, which corresponds exactly with the locality of Eberhardt LBA 210, which Singer (1945, 1978) therefore designated as the (holo)type. Eberhardt LBA 210 is comprises a single

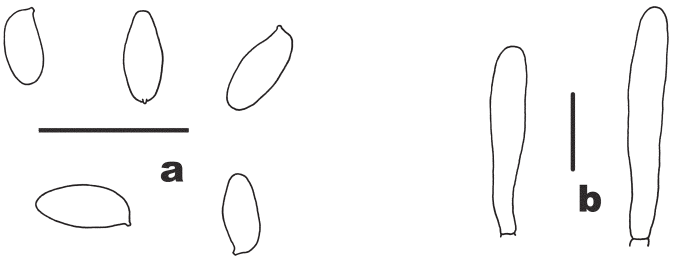

Fig. 4. Microscopic features of *Phylloporus sulcatus* (FH 3725, holotype). a. Basidiospores. b. Pleurocystidia. Bars = 20 μm.

basidioma. The dried cap is about 1.3 cm in diameter, convex, dark brown; the lamellae are decurrent, dark brown to blackish; the stipe is 2 × 0.2–0.3 cm, subcylindrical, dark, and its base is slightly enlarged; the basidiospores are [20/1/1] 10.5–12.5(–13) × (4.5–)5–5.5(–6) μm, Q = 2.0–2.36(–2.78), Q_m = 2.18 ± 0.19, yellowish to brown yellowish in KOH, smooth, ellipsoid (Fig. 4a); the basidia are 30–40 × 9–12 μm, clavate, 4-spored; the pleurocystidia are 55–70 × 9–12 μm, fairly abundant, subfusiform or narrowly clavate, with yellowish to brown yellowish vacuolar pigment, thin-walled, without encrustations (Fig. 4b). Based on our type study, *P. sulcatus* appears to differ from *P. luxiensis* in its wider basidiospores and narrower pleurocystidia. Furthermore, the stipe surface of *P. sulcatus* has no reddish tinge (Patouillard 1909, Perreau & Joly 1964, Corner 1970).

Phylloporus scabrosus M. Zang, Acta Microbiol. Sin. 18: 284, Pl. II: 5–8, 1978. Fig. 5

> Latin protologue — "*Pileus centralis, 5–8 cm diam. convexus demum plano-convexus, siccus, rufobrunneus, chryseus vel subtestaceus. Stipes 1–1.5 × 8–10 cm, subcylindricus vel subclavatus, aequalis, sordide concolor, flexus, apice striatus, sursum scabroso-furfuraceus, basim versus squamuloso-furfuraceus. Lamellae distantes, decurrentes, flavido-albidae vel flavidae, myceliis flavido-testaceis. Basidiosporae subfuscoideae laeves, 5–5.5 × 11–12.5 μm, hyalino-flavidae. Basidia 4-sporigera. Pleurocystidia 10–15 × 25–35 μm, lageniformia vel fusiformia. Cheilocystidia non vidi. spongioso-carnosus. Odor* [as "Oder"] *gratus et sapor saccharatus*." (Zang & Zeng 1978).

Type study — The *P. scabrosus* holotype comprises five basidiomata possessing the following characters: Pileus 3–4 cm in diameter, convex to applanate; surface dry, yellowish brown to chocolate brown, glabrous. Hymenophore lamellate, decurrent. Lamellae yellowish brown to dark brown, subdistant. Stipe central, 7.5–12 × 0.4–0.65 cm, cylindric, base slightly enlarged 0.9–1.2 cm, solid, firm; surface dry, concolorous with the pileus, velutinate, and also covered with disrupted squamules. Annulus absent. Texture very hard.

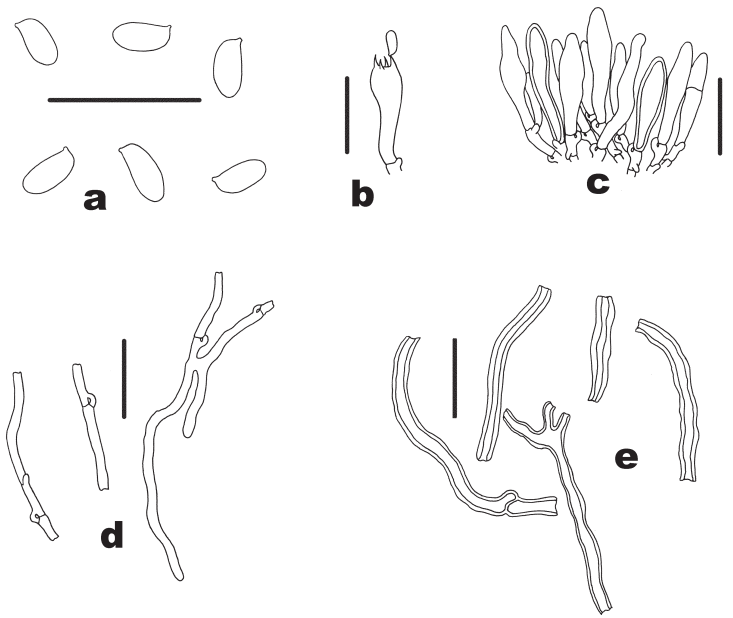

Fig. 5. Microscopic features of Phylloporus *scabrosus* (HKAS 28981, holotype). a. Basidiospores. b. Basidium. c. Cystidia. d. Generative hyphae. e. Skeletal hyphae. Bars = 20 μm.

Basidiospores [20/1/1] 6–8.5 × 3–4 μm, Q = 1.71–2.33, Q_m = 1.97 ± 0.20, yellowish brown in KOH, cylindric, smooth, thin-walled (Fig. 5a). Basidia 25–27 × 7–8 μm, clavate, yellowish brown in KOH, 4-spored (Fig. 5b). Cystidia 25–40 × 5–9 μm, finely abundant, subfusiform, cylindric or subclavate, thin- to slightly thick-walled (up to 1 μm), yellowish brown in KOH (Fig. 5c). Generative hyphae 3–5 μm in diameter, not inflated, yellowish to yellowish brown in KOH, frequently branching (Fig. 5d). Skeletal hyphae 5–13 μm in diameter, cylindric, yellowish brown in KOH, with a thickened wall (usually 2–3 μm thick, sometimes up to 5 μm thick), frequently branching (Fig. 5e). Clamp connections common in every part of the basidioma. Pileipellis and stipitipellis not recovered.

Specimen examined — **China**. **Yunnan Province**: Xishuangbanna Dai Autonomous Prefecture, Mengla County, Shangyong, Xinanshan, on fallen trunk, alt. 600 m, 24 September 1974, M. Zang 1640–HK1640 (HKAS 28981, **holotype**).

Comments — The five basidiomata of the holotype were probably not fully mature before being dried; only a few basidia with sterigmata and basidiospores were observed. The original protologue describes the basidiospores as measuring

11–12.5 × 5–5.5 µm (Zang & Zeng 1978), but our measurements differed. The holotype's basidiospores, basidia, and cystidia are filled with a yellowish brown necropigment, as observed in many other higher fungi (Locquin 1953; Yang 1997; Albee-Scott 2007; Petersen 2008a,b; Alvarado et al. 2010; Cripps et al. 2010).

Judging by the illustrations, texture, observed microscopic features, and lignicolous habit, this fungus apparently represents the genus *Lentinus* (see Corner 1981, Pegler 1983, Karunarathna et al. 2011).

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Literature cited

Albee-Scott S. 2007. The phylogenetic placement of the *Leucogastrales*, including *Mycolevis siccigleba* (*Cribbeaceae*), in the *Albatrellaceae* using morphological and molecular data. Mycological Research. 111: 653–662. http://dx.doi.org/10.1016/j.mycres.2007.03.020

Alvarado P, Manjón JL, Matheny PB, Esteve-Raventós F. 2010. *Tubariomyces*, a new genus of *Inocybaceae* from the Mediterranean region. Mycologia 102:1389–1397. http://dx.doi.org/10.3852/10-041

Bi ZS, Zheng GY, Li TH. 1993. The macrofungus flora of China's Guangdong Province. Hongkong: The Chinese University Press.

Bi ZS, Zheng GY, Li TH. 1994. Macrofungus flora of Guangdong Province. Guangzhou: Guangdong Science and Technology Press.

Bi ZS, Li TH, Zhang WM, Song B. 1997. A preliminary agaric flora of Hainan Province. Guangzhou: Guangdong Higher Education Press.

Corner EJH. 1970. *Phylloporus* Quél. and *Paxillus* Fr. in Malaya and Borneo. Nova Hedwiga. 20: 793–822.

Corner EJH. 1981. The agaric genera *Lentinus*, *Panus*, and *Pleurotus* with particular reference to Malaysian species. Beihefte zur Nova Hedwigia 69: 1–169.

Cripps CL, Larsson E, Horak E. 2010. Subgenus *Mallocybe* (*Inocybe*) in the Rocky Mountain alpine zone with molecular reference to European arctic-alpine material. North American Fungi 5: 97–126. http://dx.doi.org/10.2509/naf2010. 005. 0057

Dai XC, Li TH. 1994. Macrofungus flora of Garzê Tibetan Autonomous Prefecture, Sichuan Province. Chengdu: Sichuan Science and Technology Press.

Karunarathna SC, Yang ZL, Zhao RL, Vellinga EC, Bahkali AH, Chukeatirote E, Hyde KD. 2011. Three new species of *Lentinus* from northern Thailand. Mycological Progress (Online First). http://dx.doi.org/10.1007/s11557-010-0701-6

Li TH, Song B. 2003. Bolete species known from China. Guizhou Sci. 21(1–2): 78–86.

Li TH, Lai JP, Zhang WM. 1992. The species of *Phylloporus* known from China — with two new records to China. Edible Fungi of China 11: 29–30.

Locquin M. 1953. Recherchés sur l'organisation et le dévelopement des agarics, des bolets et des clavaires. Bull. Soc. Mycol. France 69: 389–402.

Neves MA, Halling RE. 2010. Study on species of *Phylloporus* I: Neotropics and North America. Mycologia 102: 923–943. http://dx.doi.org/10.3852/09-215

Patouillard NT. 1909. Quelques champignons de l'Annam. Bull. Soc. Mycol. France 25: 1–12.

Pegler DN. 1983. The genus *Lentinus*: a world monograph. London: Her Majesty's Stationery Office.

Perreau J, Joly P. 1964. Sur quelques *Agaricales* de la flore de Vietnam. Bull. Soc. Myc. Fr. 80: 385–395.

Petersen RH. 2008a. Scanning electron microscope images of basidiospores of *Xerula* (*Physalacriaceae*, *Agaricales*). Mycoscience 49: 19–34. http://dx.doi.org/10.1007/s10267-007-0387-z

Petersen RH. 2008b. Species of *Xerula* from sub-Saharan Africa. Fungal Divers. 30: 121–147.

Singer R. 1945. The *Boletineae* of Florida with notes on extralimital species II. The *Boletaceae* (*Gyroporoideae*). Farlowia 2: 223–303.

Singer R. 1978. Notes on bolete taxonomy II. Persoonia 9: 421–438.

Teng SC. 1963. Fungi of China. Beijing: Science Press.

Yang ZL.1997. Die *Amanita*-Arten von Südwestchina. Biblioth. Mycol. 170: 1–240.

Zang M, Zeng XL. 1978. A preliminary study on the family *Paxillaceae* of Yunnan and Tibet, China. Acta Micro. Sin. 18: 279–286.

Zang M, Li B, Xi JX. 1996. Fungi of the Hengduan Mountains. Beijing: Science Press.